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(71) Applicant (*for all designated States except US*): KVÆRNER OILFIELD PRODUCTS AS [NO/NO]; P.O. Box 9357 Grønland, N-0135 Oslo (NO).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): JAHNSEN, Ove, F. [NO/NO]; Fjellstuveien 6, N-0982 Oslo (NO). BAALERUD, Per-Ola [NO/NO]; Clausenbakken 1, N-1320 Stabekk (NO).

(74) Agent: PROTECTOR INTELLECTUAL PROPERTY CONSULTANTS AS; P.O. Box 5074 Majorstua, N-0301 Oslo (NO).

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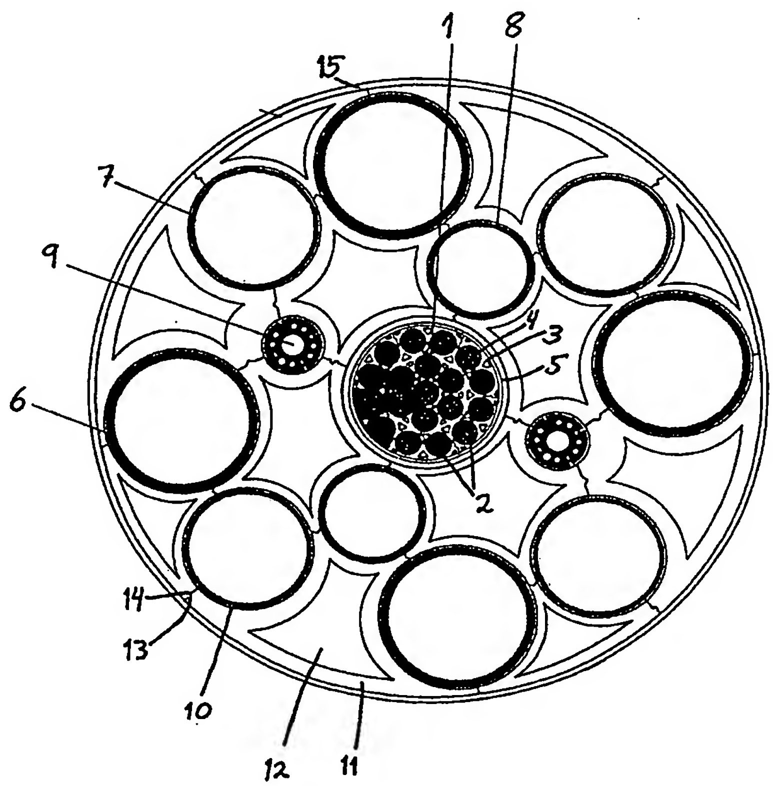
(54) Title: COMPOSITE HYBRID RISER

(57) Abstract

Composite hybrid riser, for transport of liquid/gas between the sea bed and an installation near or at the surface. The riser comprises a tension member (1), for taking up the substantial part of the tension in the riser, which tension member is made of a composite material including a matrix of a plastic material, e.g., an epoxy resin, and a large number of fibres, e.g., carbon, glass or aramid fibres. It further comprises a plurality of liquid/gas tubes (6, 7, 8), which tubes are made of a composite material including a matrix of a plastic material, e.g., an epoxy resin, and a large number of fibres, e.g., carbon, glass or aramid fibres and an outer sheath (15), which envelop the above components. The tension member (1) and the liquid/gas tubes (6, 7, 8) are longitudinally free to move, each in its own channel (10), which channels (10) are formed by a number of spacer elements (11).



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COMPOSITE HYBRID RISER

The present invention relates to a composite hybrid riser for carrying fluid between the seabed and a surface installation.

In present day oil production, several risers are arranged between the seabed and a surface installation such as a platform or a production ship. The risers may be either flexible or rigid. Lately, a number of concepts have been suggested, such as the concept shown in Figure 1, in which a plurality of rigid risers are bundled together to form a hybrid riser 21, which is led up to a buoyancy member 22 near or at the sea surface 23. Fluids are transferred between the floating production unit 24 and the buoyancy member 22 through flexible risers 25, the advantages being that the buoyancy member and the couplings are maintained at a level where the effects of waves and wind are small, and the very expensive flexible risers, which are also subject to depth limitations, are only used for the transfer between the buoyancy member and the floating production unit. Such a solution has been disclosed in NO 159.546, which also includes a piping sheath enclosing the transport tubes.

However, the above solutions employ conventional steel tubing for transport of fluids, and tension members in the form of steel wires. This makes the riser very heavy, and leads to a requirement for a large buoyancy element. In water depths exceeding approximately 1000 metres, such risers can not be used, as the pipe wall thicknesses required due to the pressure are so large, as to make the riser so heavy that it would be practically impossible to obtain sufficient buoyancy. The tension in such a pipe would also exceed that which is possible to handle. In addition to the high buoyancy requirement, there would also be a requirement for a sturdy foundation on the seabed. Needless to say, building such a foundation at great depths is very costly.

Another disadvantage, which applies also at depths significantly less than 1000 metres, is associated with manufacture and tow-out of the riser. If the riser is manufactured onshore as one whole length or as long sections, for later tow-out to the installation site, the transportation itself will cause fatigue in the riser. Such fatigue shortens the expected working life of the riser, maybe by as much as 10%. The transportation

distance therefore has to be as short as possible, thus limiting the number of possible manufacturing sites.

If the riser is to be put together from relatively short sections, which are transported on board for example a barge, the installation process will be made more expensive.

The present invention aims to provide a composite hybrid riser, which comprises those pipelines and cables normally needed between the seabed and a surface installation, and which does not or to a very much smaller degree exhibits the above mentioned disadvantages. This is achieved through the features stated in Claim 1.

The present invention achieves a formidable weight saving, as components made from composite materials have a weight that is only a fraction of that of steel components. As a result of the weight saving, the requirements for buoyancy and foundation work are reduced.

Further, the fatigue life is increased to up to 10 times that of steel. Transportation to the installation site will therefore only cause a negligible reduction in the fatigue life, consequently the tow-out distance is not of critical importance, and the choice of manufacturing sites will be considerably greater.

Small dimension risers according to the invention may be coiled on the deck of a barge during shipment, thus simplifying transportation considerably.

A lighter and more flexible riser also makes installation easier. The capacity of cranes, winches and other equipment used may be reduced considerably. Installation may also be speeded up, due to the low weight and increased flexibility, and to the fact that the riser according to the invention tolerates a greater strain.

Reference is made to figure 2, which shows a cross section through a composite hybrid riser according to the present invention.

The composite hybrid riser according to the invention comprises a centrally disposed tension member 1, which comprises a plurality of strands 2, preferably light, strong fibres such as carbon fibre, glass fibre or aramid fibre, in a matrix of plastic material, e.g. epoxy resin, and spacers 3, which have been arranged so as to keep the strands spaced apart, and which define channels 4, in which the strands 2 are freely movable in the longitudinal direction. Preferably, the strands are coiled around the tension member, e.g. in a coil or a Z-wrap. This technology has been described in detail in _by the same applicant. The tension member is connected to a foundation on the seabed through one end, and to a buoyancy body through the other end. Instead of or in addition to a centrally disposed tension member 1, there may be an arrangement of several non-centrally disposed tension members.

An enclosing sheath 5 holds the tension member 1 together. The composite hybrid riser according to the invention also consists of a plurality of fluid transport tubes 6, 7 and 8, of various dimensions, for transport of production fluid and/or for water injection. In special cases with small requirements for tensile strength, or where the pipelines themselves have sufficient tensile strength, it is possible to eliminate the central tension member, with the tubes 6, 7 and 8 themselves acting as tension members.

The composite hybrid riser may also comprise control cables 9, which again comprise signal cables, electrical conductors, hydraulic lines, fluid transport tubes and other items normally included in a conventional control cable. These cables and lines are suitably arranged in the respective channels, in such a manner as has been described for control cables, or so-called umbilicals, in Norwegian patent 174940 by the same applicant.

Each tube 6, 7 and 8, as well as control cables 9, are arranged so as to be freely moveable in the longitudinal direction in their respective channels 10, which are defined by spacers 11. The spacers are preferably designed with one or more cavities 12, which during installation may be filled with air, water or another medium such as synthetic foam, in order to control the buoyancy. In order to keep the spacers in place, relative to each other, projections 13 and recesses 14 have been formed on the surfaces where the

spacers 11 touch. Preferably, the spacers are elongated and extend over the whole or large parts of the length of the composite hybrid riser.

The tubes 6, 7 and 8 may be arranged in a straight line, or they may be wound around the tension member 1, e.g. in a coil or a Z-wrap. This makes the riser more flexible, and easier to coil. The tubes 6, 7 and 8 are made from a composite material comprising a matrix of plastic material, e.g. an epoxy resin such as HDPE. The tubes may for instance be constructed by winding the fibres in multiple layers, with the fibres preferably arranged in parallel, and with at least some of the layers intersecting. A matrix of plastic material is placed between each layer of fibres, enclosing the fibres completely. This gives a high resistance to external, physical influences. The tubes may, if desired, be constructed from pre-impregnated fibres, so-called prepreg. These are fibres that have been coated with plastic material in advance. The plastic material is treated after or during the winding of the fibres, for instance with heat, in order to cause it to melt completely or partially, for it to run together to form a continuous matrix.

The tubes 6, 7 and 8 may be manufactured as a whole length, or they may consist of several tube sections, which are joined during the manufacture of the riser.

An outer, protective sheath 15 is arranged around the complete composite hybrid riser, in order to keep the elements in their place, in relation to each other. The outer sheath is preferably made from PVC.

Since the tubes 6, 7 and 8 and the control cables 9 are freely moveable in the longitudinal direction in the channels 10, it will be possible in certain cases, particularly when the dimensions are small, to coil the composite hybrid riser for transportation to the installation site. If the dimensions of the riser are so great as to make coiling practically impossible, it will be possible to tow it to the installation site, for instance suspended between two towing vessels. As the riser, irrespective of dimensions, has a certain flexibility that is greater than that of a correspondingly dimensioned steel riser, it will be able to absorb relatively large movements without being overloaded or fatigued.

The tow can therefore take place under conditions of greater wave heights than those that are allowable for a steel riser.

Moreover, the above construction makes it possible to obtain a riser that contains fewer reinforcing fibres, and has a comparatively small diameter, which will give a further reduction of the bend radius.

The central tension member may be pretensioned during installation, so as to absorb all static and dynamic loads. Thus, the tubes and the remaining elements of the riser will not be subjected to any significant loads. It is also possible for the tension member to take over the task of anchoring the floating installation to the seabed, either by itself or in combination with tension legs or other risers.

A fibre-optic cable may be included with the fibres in the tension member. The tension and the structural integrity of the tension member may be monitored through this, in order to keep account of the state of fatigue in the tension member, prevent overloading, and to receive an early warning of any weakening of the tension member.

C l a i m s

1.

Composite hybrid riser for transport of fluid between the seabed and an installation near or at the surface, w h e r e i n is comprised a tension member (1) for absorption of the greater part of the riser tension, which tension member is made from a composite material comprising a matrix of a plastic material such as an epoxy resin, and a large number of fibres, e.g. carbon, glass or aramid fibres, a plurality of fluid tubes (6, 7, 8), which tubes are made from a composite material comprising a matrix of a plastic material such as an epoxy resin, and a large number of fibres, e.g. carbon, glass or aramid fibres, and an outer sheath (15) enclosing the above mentioned components, the tension member (1) and the fluid tubes (6, 7, 8) being arranged so as to be freely moveable in the longitudinal direction in their respective channels (10), which channels (10) are formed by a number of spacers (11).

2.

Riser according to Claim 1, w h e r e i n is comprised one or more control cables (9) containing for instance signal cables, electrical conductors, hydraulic lines, fluid transport tubes and more, which control cables are arranged so as to be freely moveable in the longitudinal direction in a respective channel (10).

3.

Riser according to Claim 2, w h e r e i n the respective cables and lines in the control cable (9) are arranged so as to be freely moveable in the longitudinal direction in their respective channels in the control cable (9).

4.

Riser according to Claim 1, w h e r e i n the tension member is centrally disposed..

5.

Riser according to any preceding claim, w h e r e i n the tension member comprises a plurality of strands (2) kept at a distance from each other by spacers (3), the spacers (3) defining channels (4) in which the strands (2) are freely moveable in the longitudinal direction.

6.

Riser according to any preceding claim, w h e r e i n the spacers (11) comprise cavities that may be filled with a medium in order to control the buoyancy.

7.

Riser according to any preceding claim, w h e r e i n the spacers (11) and the tubes (6, 7, 8), and possibly the control cables (9), are wound around the tension member (1) in a coil or a Z-wrap.

8.

Riser according to any preceding claim, w h e r e i n the tubes (6, 7, 8) form one continuous length in the riser.

9.

Riser according to any of Claims 1-7, w h e r e i n the tubes (6, 7, 8) are made up of several sections joined together.

10.

Riser according to any preceding claim, w h e r e i n a fibre-optic cable is included with the fibres in the tension member (1), for monitoring of the tension in the tension member (1) and/or the structural integrity of this.

11.

Use of composite hybrid risers for the anchoring of a floating installation.

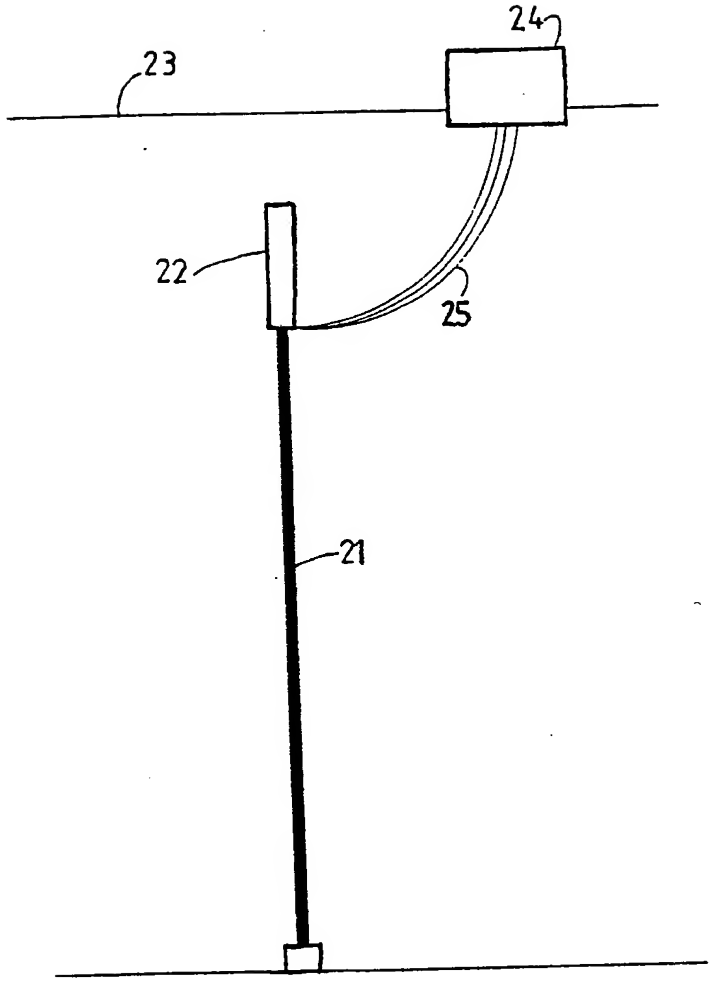


Fig.1

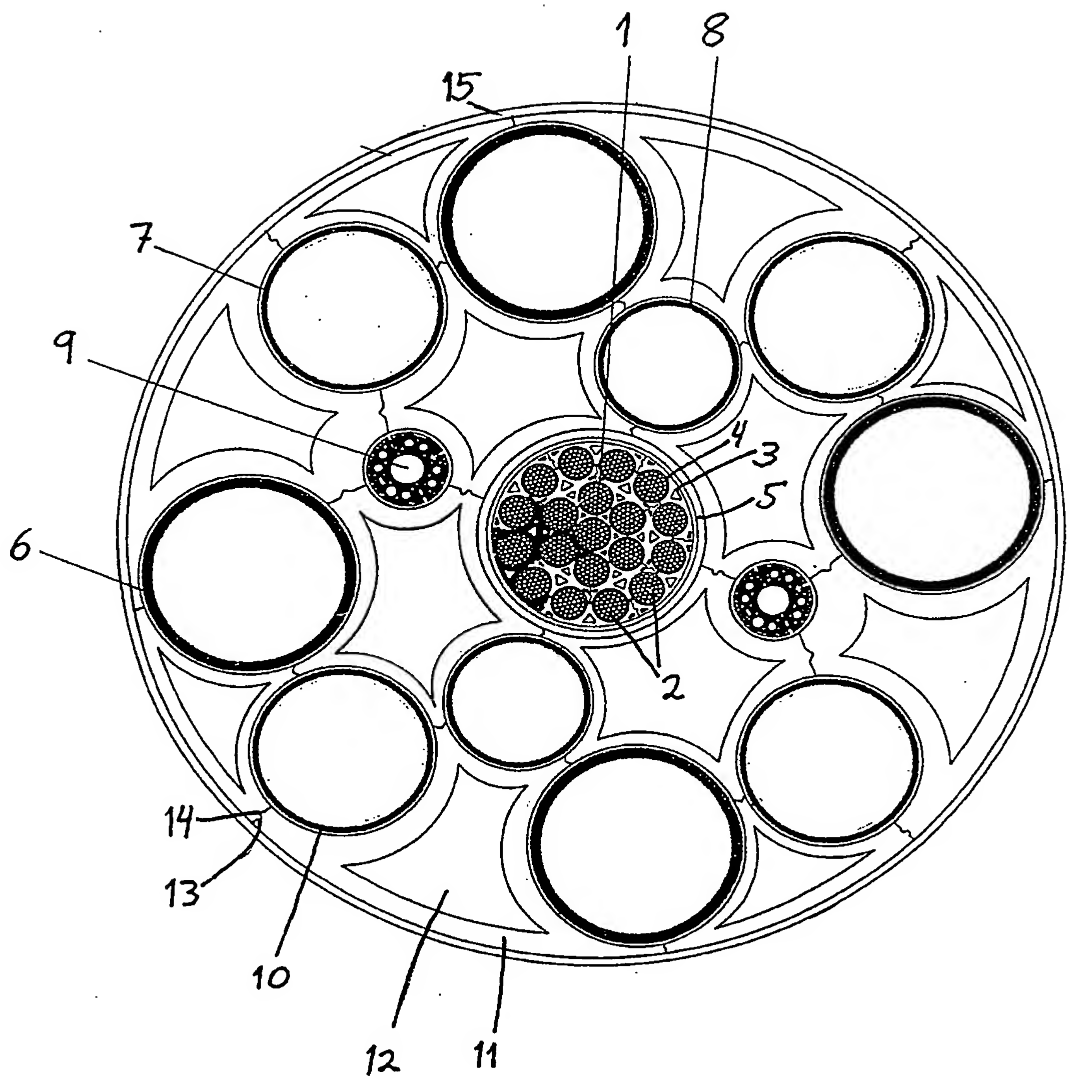


Fig.2